

Is Bike Sharing Competitor, Relief or Supplement to Public Transport?

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1 ABSTRACT

In many cities the growing popularity of bicycle-sharing schemes has added additional options to the transport regime. A significant amount of research has been stipulated by data recorded from lending and returning bicycles at geographically diverse stations. In this contribution, focus will be laid on the relationship that the bike-sharing system of the City of Vienna (CityBike Wien – CBW) has with its well developed public transport system. Does bike-sharing serve as competitor, relief or supplement? By surveying the total CBW trip data of 2015 – about 1 million records – we approach to answer this question. We cleanse and route all bicycle trips and compare them with routed alternative public transport trips in terms of travel time ratios. In interviews of 1,389 CBW users conducted in July and September/October of 2016, we ask about the purpose of their trip, the position of the CBW as part of their door-to-door trip, the role of CBW as substitute for other means of transport and the reasons for this substitution. The age group that has the highest number of users among CBW and the shares of tourists/visitors and locals using CBW is identified. Identifying the top 10 of trips from the cleansed dataset and mapping them emphasizes the role that we identify for Vienna's bike-sharing system in the inner city: A supplement to public transport.

Keywords: bike sharing; public transport; relationship; GIS-analysis; questionnaire

2 INTRODUCTION

On one hand Vienna is known for its long and consistent public transport tradition. On the other hand Vienna started in 2003 its new bicycle sharing system (BSS) CityBike Wien, which now holds 121 stations with 3,097 boxes and a fleet of 1,500 bicycles and its know-how was exported throughout the world to other BSS that started later on.

As sharing booms, the existence of these new elements, recently added to our urban transport systems, leads to the question of the role they play. Is bike-sharing a competitor, relief or supplement to other modes of transport that already existed?

For the analysis of the question we used a full-year dataset of the BSS City-Bike Wien and the routing engines of Bike City Guide Apps and Wiener Linien public transport operator.

The characteristics of BSS have in many aspects already been covered by various studies; e.g. ranging from urban form's impact on bicycle flows (Faghih-Imani, Eluru, El-Geneidy, Rabbat, & Haq, 2014) via typologies of users (M. Vogel et al., 2014) to the impacts of BSS on health (Woodcock, Tainio, Cheshire, O'Brien, & Goodman, 2014).

In an example for previous research Beecham and Wood conducted analysis of spatial data compared to BSS usage data for London. Their findings concentrated on different usage patterns in comparison of female to male users. Furthermore even detailed analysis of characterizations for groups such as postwork or lunchtime trips is possible. (R. Beecham & J. D. Wood, 2014)

Another issue is the future development outlook of CBW. Possible answers are extending or concentrating the CBW system in Vienna.

3 METHODS

3.1 Survey

To get to know how the people use CBW and for which kinds of purposes, we conducted a survey in July and September/October 2016 by interviewing CBW users, while they were borrowing out or bringing back

their CBW bikes at one of the viennese stations. 820 users were interviewed in July and in September/October 569, altogether 1389 interviews were carried out.

The questions concentrated on the topics:

- Position of the CBW as part of door-to-door trip.
- Purpose of trip.
- Role of CBW as substitution of other means of travel and if so for which reason.

To get a better knowledge about the participants of the survey, we asked them if they are tourists / visitors or locals, if they are in possession of a seasonal ticket, a driving licence and / or have access to a car. Also the gender was noted and age in 10-years-steps between 20 and 70.

With an exception of just three stations the return rate of adressed users was over 50% in the remaining 117 stations.

3.2 Data analysis

To identificate the interdependency between PT and CBW we determined the journey times of all cycling and PT trips for all 14,520 relations, from every CBW-station to all other CBW stations. (121 CBW stations, 121*120 relations, only direct trips)

To consider different intensities in PT intervals and CBW lending processes at different day times and weekdays several time periods were defined:

- section 1: weekday Peak, 05am-09pm
- section 2: weekday night, 01am-05am
- section 3: weekend Peak, 09am-09pm
- section 4: weekend night, 01am-05am

Not considered into comparison were trips that suggest the use of Nightline busses (these are running at night-time before workdays).

In comparison the full set of 2015 CBW trip data was analysed. All round or indirect trips were removed. Further all bikes reported stolen were deleted from the dataset as well as all trips to or from a temporary station.

4 RESULTS

4.1 Survey

Out of 1,389 users we interviewed, 57.7 % were male and 42.3 % female. The dominant age group was 20-29 with almost 50 % share. 35 % were tourists/ visitors, 65 % were locals. 48 % were in possession of a seasonal ticket for Wiener Linien (public transport operator). While 78.9 % were in possession of a driving licence only 26.9 % had the possibility to use a car instead of CBW. 78.3 % used CBW as their main means of transportation, 20.9 % used it as a connection to public transport, only 0.8 % used it as a connection between two different public transport modes.

The table 1 shows that in an overwhelming number of cases CBW replaces at least one other means of transportation.

Does CBW substitute other modes of transportation?	Absolute	share [%]
Yes	1,284	92.4
No	105	7.6

Table 1: Share of responses, where CBW substituted another mode of transportation

As shown in figure 1 the purpose of a trip with CBW is leisure with a share of 65 %. The way to or from work counts with a share of 15 %.

CBW substitutes with a share of 71.4 % trips otherwise made by PT followed by ways made by walking with 15.9 % (Figure 2). Figure 3 shows that out of the role CBW has as part of a door-to-door trip it dominantly

substitutes PT trips with a share of 60 % as main means of transport and 64% as connector to other modes of transportation.

Reasons for substitution are exercise, cheaper and faster compared to PT, faster compared to walking and more eco friendly compared to car use (figure 4).

Is the argument of more environmental friendliness of CBW compared to cars related to collegiate users? The results indicate that it probably is.

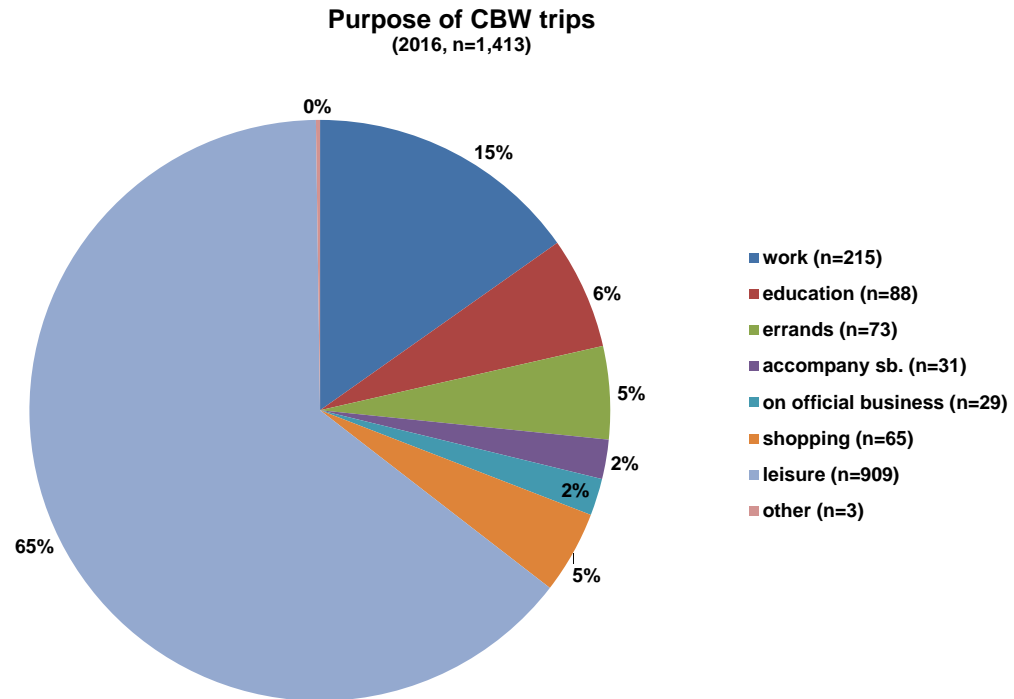


Fig.1. Purpose of CBW trips

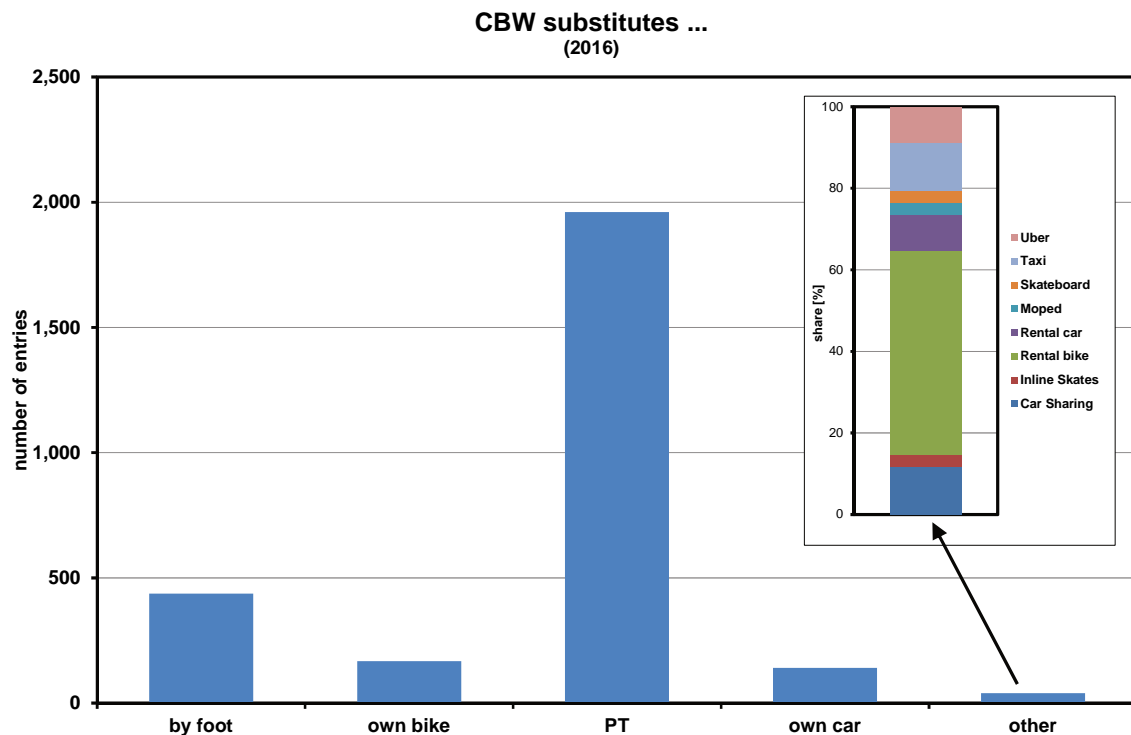
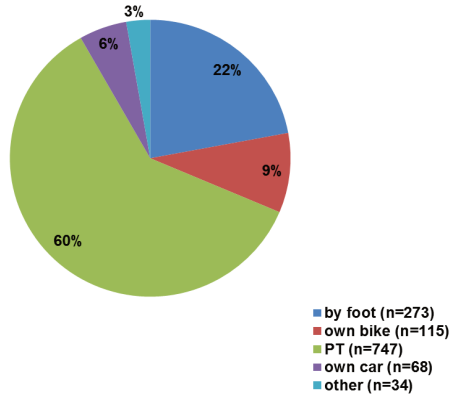


Fig.2. Substitution of trips by CBW

If CBW is used as main means of transportation,
then CBW serves as substitute for ...
(2016, n=1,237)



If CBW is used as connector to other modes of transport,
then CBW serves as substitute for ...
(2016, n=289)

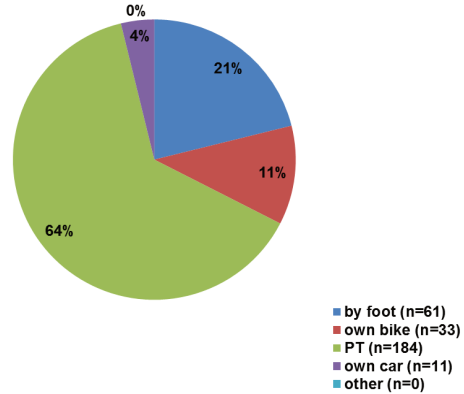


Fig.3. Role of CBW as part of door-to-door trips and substitution of other modes of transport

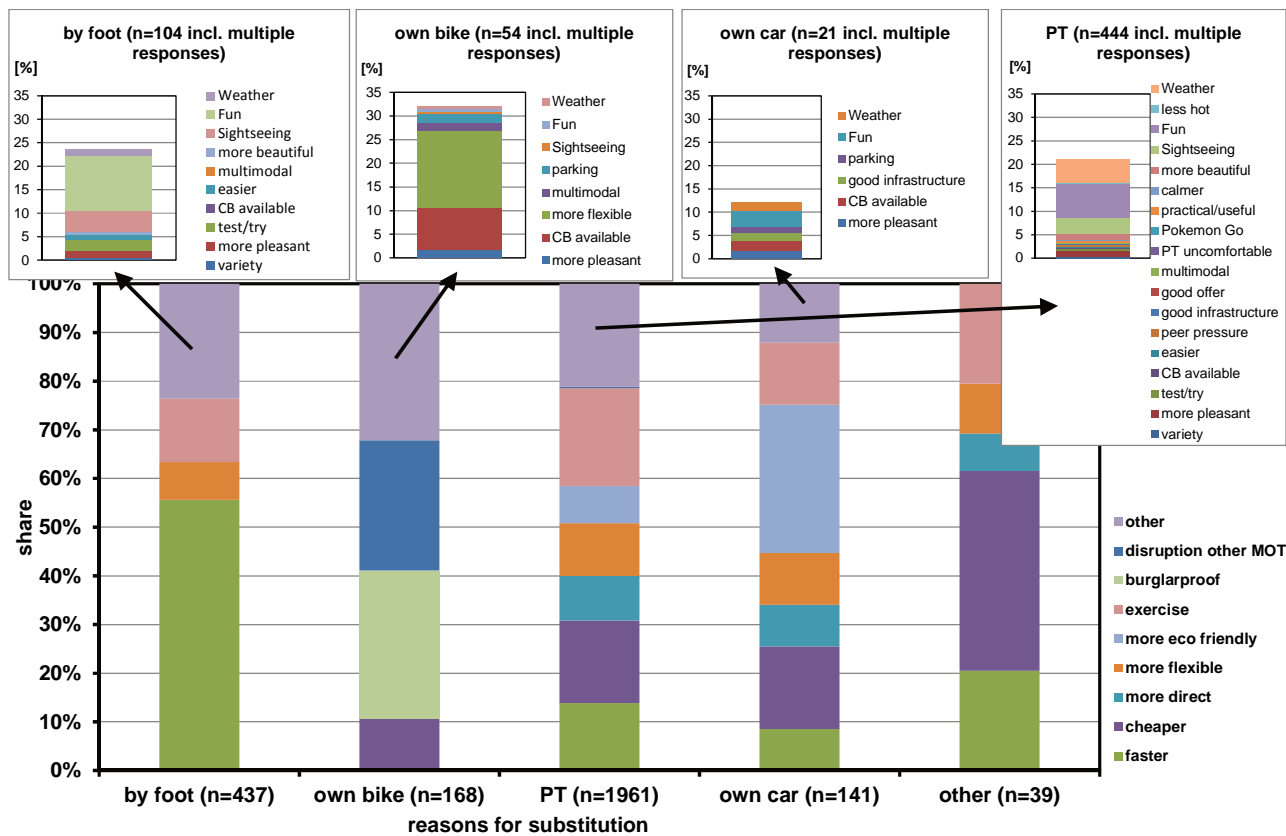


Fig.4. Reasons for substitution

4.2 Data analysis

One result of the data analysis shows that only 10 % of trips take place on 50 % of connections and 45 % of trips take place on 10 % of connections (for 402 connections no direct CBW trips at all were detected in 2015). Only a few connections hold an important role as high frequency trip generators.

To measure the effect of whether CBW is a competition or supplement for PT, we assigned the direct trips onto PT and CityBike routes (Figure 5). The left map shows the PT routes which are potentially replaced by switching to the bike routes shown in the right map. The maps confirm previously identified usage patterns (student trips, feeder trips to PT hub, pedestrian/shared space zone).

As part of the data analysis a detour factor for CBW was calculated by comparing the direct distance of CBW trips to the routing distance. The result shows a detour factor of 1.29 which means that a CBW user will probably cycle a roughly 30 % longer distance than the beeline would be from station to station.



Fig.5. Potential decrease of trips on PT network (left), increase of bicycle trips (right) (Leth, U., & Brezina, T., 2017)

5 DISCUSSION

The next step in improving our work lies in connecting adjoining urban densities (e.g. residents, jobs) and trip generators (e.g. transport hubs) with CBW trip and station data. As trip generation is closely related to attractors and generators in the area around stations, this improvement could increase the explanatory value.

Including fine grained weather data (intense rain, heavy snowfall, harsh temperatures) and topography would as well improve the understanding of the CityBike's role as a supplement to public transport. Further effort could be put in the consideration of other factors influencing mode and route choice such as the ratio of travel times and distances by bike vs. car. An effort could be put into the question how longterm PT operating limitations affect CBW use on a overall system level.

Some limitations due to availability of data have been located as socio-economic data isn't available on a level of detail that would have been useful for correlation to stations.

Further comparison with results of surveys in other cities would increase the importance of the results of this study.

A possible derived deduction out of the Survey data of lenghts of access and departure paths and a connected diagram as cumulative frequency allocation wasn't possible due to resource constraints.

6 CONCLUSION

The data analysis shows that roughly half of the direct CityBike trips occur on only 10 % of the connections. But as our work also proves that short trips are the main target of CBW users it is a coherent conclusion.

Comparing 939 million annual trips with PT in Vienna to currently 1 million CBW trips shows that CBW is not big enough to actually appreciably rival the PT in Vienna.

About the research question of PT network densification vs. grid-expansion: during this study the role of CBW for dispersion was proven. So the assumption is that a network densification would be followed by an increase of usage.

On the other hand extension along PT axes in the outskirts could also be wise.

We therefore conclude that CBW works today as a supplement and addition to the PT network in Vienna.

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